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ILLUSTRATIONS OF FUNGI—III

William A. Murrill

Most of the species here figured belong to the large and important class of wood-destroying fungi, which are of special interest to the forester. While none of them are poisonous, most of them are too tough to be used for food. *Amanitopsis vaginata,* the only species described here that is not generally found on wood, must be carefully distinguished from the deadly species of *Amanita* when collecting it for the table.

Pholiota adiposa (Fr.) Quél.

Fat Pholiota

Plate 7. Figures 1 and 2. $\times \frac{1}{4}, \frac{1}{3}$

Pileus firm, fleshy, convex to expanded, incurved at the margin, 4–7 cm. broad; surface very viscid when moist, shining when dry, lemon-yellow to egg-yellow, with conspicuous bay or testaceous scales, which often become darker, especially near the tip; flesh white or yellowish, almost tasteless, not poisonous; gills adnate, close, pale yellow or isabelline, becoming ferruginous; spores ellipsoid, smooth, ferruginous, $7–8 \times 5 \mu$; stem subequal, white or yellowish above, slightly darker below, squamose below the delicate, floccose annulus, 5–10 cm. long, 5–8 mm. thick.

This species is conspicuous and quite common in autumn in dense clusters on dead trunks and stumps of deciduous trees, in Europe and North America. It is rarely eaten, because of its

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slimy cap and almost tasteless flesh, but the caps can be easily peeled, and they are readily digested when young and fresh. The illustrations are made from specimens grown between sections of poplar trunks placed for several months in the basement of the museum building of the Garden. By separating the sections, an excellent view, as seen in figure 2, was obtained of the early stages of the young sporophores, as they grew outward toward the light from the fruiting mycelium near the center of the trunk.

Inonotus dryophilus (Berk.) Murrill

OAK-LOVING INONOTUS

Plate 7. Figure 3. $\times \frac{1}{3}$

Pileus thick, unequal, unguliform, subimbricate, rigid, 7–8 $\times$ 10–14 $\times$ 2–3 cm.; surface hoary-flavous to ferruginous-fulvous, becoming scabrous and bay with age; margin thick, usually obtuse, sterile, pallid, entire or undulate; context ferruginous to fulvous, zonate, shining, 3–10 mm. thick; tubes slender, concolorous with the context, about 1 cm. long, mouths regular, angular, 2–3 to a mm., glistening, whitish-isabelline to dark fulvous, edges thin, entire to toothed; spores subglobose, smooth, deep ferruginous, 6–7 μ; cystidia scanty and short; hyphae deep ferruginous.

This rare species occurs only upon oak trunks, and has been previously reported from Virginia, Wisconsin and three intermediate states. The accompanying figure was made from a rather abnormal specimen found last autumn in Bronx Park on a living white oak. The trunk of this tree was evidently attacked by the fungus from the base up to a height of fifteen or twenty feet, or more, as indicated by the appearance of the sporophores at points where dead limbs had been removed. The white oak is an exceedingly valuable tree, and any fungus that attacks it, even though rare, is of importance to the forester.

Pholiota lutea Peck

YELLOW PHOLIOTA

Plate 7. Figure 4. $\times \frac{1}{2}$

Pileus thick, fleshy, firm, convex to nearly plane, 5–10 cm. broad; surface silky, squamulose near the center, flavous to

luteous, margin sterile and slightly incurved; flesh yellowish, of pleasant odor but bitter taste; gills adnexed to somewhat decurrent, yellowish to deep ferruginous; spores ellipsoid, ferruginous, $9 \times 5\,\mu$; stem $5–7 \times 0.6–1$ cm., solid, firm, ventricose, fibrillose, concolorous below, nearly white above; ring rather large and conspicuous, soon colored by the copious spores.

This species is very handsome, occurring in conspicuous clusters on dead trunks in woods from August to October. Although separated from the European species *Pholiota spectabilis* by Professor Peck in 1898, it is very closely related to that species and might be considered only a variety of it by some authorities. Both species are considered very rare in this country. The illustration was made from specimens collected near Bronx Park by Mr. E. C. Volkert, September 24, 1908, and determined by Professor Peck. Another specimen was brought in last fall from Forked River, New Jersey, by Mr. W. H. Ballou.

Amanitopsis vaginata (Bull.) Roze

SHEATHED AMANITOPSIS

Plate 7. Figure 5. $\times \frac{1}{2}$

Pileus thin, fragile, companulate to expanded, 3–8 cm. broad; surface dry, glabrous, deeply striate on the margin, exceedingly variable in color, ranging from nearly white to reddish-brown; gills free, fragile, white; spores globose, smooth, hyaline, $8–10\,\mu$; stem nearly equal, scarcely enlarged below, glabrous or adorned with minute scales, variable in color, hollow or stuffed within, 6–12 cm. long, 4–8 mm. thick, entirely devoid of a ring, but conspicuously sheathed at the base with a long, loose, white volva, portions of which are sometimes carried up as patches on the cap.

This attractive and very variable species is abundant in woods throughout Europe and North America during summer and autumn, and possesses excellent edible qualities. It may be distinguished from species of *Amanita,* some of which are deadly poisonous, by the total absence of a ring on the stem, although the conspicuous volva at the base suggests its close relationship to that genus. The variations in color presented by this species are often very bewildering to the beginner.

Ischnoderma fuliginosum (Scop.) Murrill

SOOTY ISCHNODERMA

Plate 7. Figure 6. $\times \frac{1}{10}$

Pileus very large, subimbricate, laterally connate, effused-reflexed, often covering the entire under surface of logs, the reflexed portion applanate, 5–15 cm. long, 10 to many cm. broad, 1–2.5 cm. thick; surface pelliculose, floccose, rugose, zonate, fuliginous, ivory-black and dark fulvous, with a conspicuous resinous appearance; margin acute, concolorous, inflexed on drying, entire or undulate; context fleshy, becoming corky with age, very firm and rather fragile when dry, light brown, 5–10 mm. thick; tubes pallid to umbrinous, 5–8 mm. long, mouths minute, white, angular, equal, becoming umbrinous and somewhat irregular with age, edges thin, fimbriate to lacerate; spores smooth, cylindrical, subcurved, hyaline, $4\text{–}6 \times 1.5\text{–}2\,\mu$.

This species is rather common throughout the United States and Europe, occurring on stumps and fallen trunks of basswood, maple, fir, spruce, and certain other trees. When young it is rather fleshy, but soon becomes corky, and is always too tough for food. There is no evidence that it attacks living trees, but it runs rapidly over the under side of large logs, destroying the wood. The accompanying illustration was made from specimens growing on an old stump near the Lorillard mansion. Unfortunately, it was necessary to reduce them very much in size.

THE COMPOSITION OF A DESERT LICHEN FLORA*

BRUCE FINK

The plants upon which the considerations to follow are based were collected in the vicinity of the Carnegie Botanical Laboratory. The collections and field notes were made by Messrs. J. C. Blumer and V. M. Spalding. The collecting was quite carefully done, and a considerably larger amount of material was examined than the rather short list of species given below would indicate. That the list falls considerably short of the entire lichen flora of the area is indicated by the fact that each collection, after the first, brought to light one or more new forms, though collected at random and including a small number of species. However, lichens collected by persons not well acquainted with lichen species are likely to be the more common, conspicuous and characteristic ones. Therefore, some valuable conclusions can be drawn from the study of these specimens, together with a statement of problems which could be solved only through an exhaustive study on the ground, by one well acquained with lichens and the problems and methods of work in ecology. The list of species is as follows:

1. *Endocarpiscum placodizans* (A. Zahlbr.) Fink.
2. *Heppia deserticola* A. Zahlbr. Bull. Torr. Bot. Club **35**: 300. 1908.
3. *Heppia virescens* (Despr.) Nyl. Syn. Lich. **2**: 45. 1860.
4. *Pyrenopsis Schaereri* (Mass.) Tuck. Syn. North Am. Lich. **1**: 135. 1882.
5. *Collema* sp., sterile.
6. *Synechoblastus coccophorus* (Tuck.) Fink.
7. *Leptogium arizonicum* A. Zahlbr. Bull. Torr. Bot. Club **35**: 299. 1908.

* Contributions from the Botanical Laboratory of Miami University—II.

8. *Acarospora xanthophana* (Nyl.) Fink, Bot. Gaz. **38**: 271. 1904.
9. *Acarospora xanthophana dealbata* (Tuck.) Fink.
10. *Acarospora Carnegiei* A. Zahlbr. Bull. Torr. Bot. Club **35**: 297. 1908.
11. *Acarospora cervina cinereoalba* Fink, Minn. Bot. Stud. **2**: 319. 1899.
12. *Acarospora cineracea* (Nyl.) Hedlund in Litt.
13. *Lecanora muralis* (Schreb.) Tuck. Gen. Lich. 113. 1872.
14. *Lecanora cinerea* (L.) Sommerf. Suppl. Fl. Lapp. 99. 1826.
15. *Lecanora calcerea contorta* (Hoffm.) Tuck. Syn. North Am. Lich. **1**: 199. 1882.
16. *Placodium elegans* (Link.) Ach. Lich. Suec. Prod. 102. 1798.
17. *Placodium elegans brachylobum* (A. Zahlbr.) Fink.
18. *Placodium murorum* (Hoffm.) Ach. Lich. Suec. Prod. 101. 1798.
19. *Placodium cinnabarinum* (Ach.) Anzi, Lich. Sondr. **1**: 43. 1860.
20. *Placodium amabile* (A. Zahlbr.) Fink.
21. *Placodium lobulatum* (Sommerf.) Fink.
22. *Teloschistes modestus* (A. Zahlbr.) Fink.
23. *Parmelia conspersa* (Ehrh.) Ach. Meth. Lich. 205. 1803.
24. *Physcia* sp.
25. *Buellia lepidastra* Tuck. Syn. North Am. Lich. **2**: 90. 1888.
26. *Buellia* sp., near *B. concinna* Th. Fr. Lich. Arct. 232. 1860. (fide Theodor Hedlund).
27. *Dermatocarpon miniatum* (L.) Fr. Syst. Orb. Veg. 259. 1825.
28. *Dermatocarpon peltatum* (Tayl.) Fink.
29. *Dermatocarpon* sp., near *D. compactum* (Mass.) Fink.
30. *Dermatocarpon rufescens* (Ach.) A. Zahlbr. in Eng. and Pr. Pflanzenfam. **1**^{1}: 60. 1907.
31. *Endocarpon Schaereri* (Koerb.) Fink.
32. *Verrucaria fuscella* (Turn.) Ach. Lich. Univ. 289. 1810.
33. *Verrucaria nigrescens* Pers. Ust. Ann. Bot. **14**: 36. 1795.

These lichens form a remarkable assemblage of plants. The collectors were asked to find any loosely foliose or fruticose

lichens, but only a single loosely foliose species was sent and not a single fruticose one. Moreover, the loosely foliose lichen sent is especially adapted structurally, as will be noted below. Numbers 3, 5, 6, 7, 28, 30 and 31 were found on the ground and number 24 was collected on the base of a tree trunk in a moist place. These numbers may be omitted from the considerations to follow immediately.

COMPARISONS WITH LICHEN FORMATIONS OF OTHER REGIONS

The other twenty-five lichens of the list were found on rocks and bear a striking resemblance to those of a "*Lecanora* formation of exposed granite."* The lichens of this formation of exposed granite in Minnesota, and those of several other similar formations studied by the writer in the same state, show barely a larger proportion of foliose species than do the lichens of the rocks at Tumamoc Hill. Not only is there this general structural likeness; but when we take into account the difference in latitude and in moisture conditions, it is remarkable that the genera of the list for Tumamoc Hill are largely represented in the formations of the exposed rocks in Minnesota, while there is also a very considerable likeness in the species. Coville and MacDougal give 11.74 inches as the average annual precipitation of moisture at Tucson, during fifteen years of observation;† while the writer found the record for Granite Falls, Minnesota, where the Minnesota lichen formation used in the comparison above occurs, to be 21.83 inches.‡ This difference is doubtless the main one of the factors which give the Arizona region a lichen flora as a whole very different from that of the Minnesota area, but which are not sufficient to produce striking differences between the lichen floras of rocks in the former region and those of the exposed rocks in the latter place. H. Zukal says: "Auch zeigen die an der Südseite an nackten Felsen wachsenden Flechten und

* Fink, Bruce. Contributions to a Knowledge of the Lichens of Minnesota.—V. Lichens of the Minnesota Valley and Southwestern Minnesota. Minn. Bot. Stud. **2**: 286–288. D 1899.

† Coville, F. V., and MacDougal, D. T. Desert Botanical Laboratory of the Carnegie Institution. Pub. Carnegie Institution of Washington 26. N 1903.

‡ Fink, Bruce. Op. c. 279.

jene heisser, regenarmer Gegenden und Wüsten den gemeinsamen Charakter der ausserordentlich verdickten Aussenrinde."§ The studies of the present writer in agreement with those of Zukal show that lichen formations of horizontally exposed rocks in regions of average rainfall, as well as those of perpendicular or inclined, southward-facing rocks, may show the same structure as the lichens of the desert rocks.

In connection with the observations of Zukal and related to other statements above and to problems to be considered below, statements of the writer in a paper recently published are of special interest. In the study of the lichen formations of sandstone ripraps,|| it was found that the northward-sloping riprap supported a lichen formation containing quite a proportion of fruticose and foliose species, while the formation of a southward-facing riprap a few feet away was composed almost exclusively of closely crustose and strongly corticate species. The latter formation, like the lichen aggregations of the rocks in the vicinity of the Carnegie Desert Laboratory, shows *Acarospora* commonly present, while the members of this genus were extremely rare on the northward-facing riprap. This northward-facing riprap supported an abundance of *Biatora myriocarpoides*. which was replaced on the southward-facing riprap by *Buellia myriocarpa,* a lichen whose structure protects it better against the drier habitat through the greater tendency toward disappearance of thallus and the better development of such structures as exciple, hypothecium and paraphyses. It is significant that *Biatora,* with its poorly developed exciples, hypothecia and paraphyses, is entirely wanting in the lichens sent from the area about the Desert Laboratory.

General Consideration of Structure

It is well known that the more a thallus is branched or lobed, the more young, tender, growing points are exposed and the greater the amount of transpiration of moisture, other things

§ Zukal, H. Morphologische und biologische Untersuchungen über die Flechten. Sitzungsbericht. kaiserl. Akad. Wien. **14**: 1308. O 1895.

|| Fink, Bruce. A Lichen Society of a Sandstone Riprap. Bot. Gaz. **38**: 269–279. O 1904.

being equal. One may look through the whole list of twenty-five lichens of the rocks without finding more than four species with conspicuously lobed thalli. These four are *Placodium elegans, Placodium murorum, Lecanora muralis* and *Parmelia conspersa;* and these plants, when compared with lichens of the same species from more moist climates, show, as a whole, a perceptible shortening of the lobes of the thalli. Many lichens having the fruticose habit, as certain species of *Evernia,* can scarcely maintain themselves in open places, where subjected to strong gales, but seek protected habitats, as in dense forests, where they will not be torn from their substrata. Also, these fruticose species are usually conspicuously branched and present much surface and many tender, growing areas to the drying effects of winds and dry atmosphere. It is, therefore, not quite certain after all, until further investigation can be made, whether the restriction of lichens about the Desert Laboratory to closely adnate and poorly lobed or branched forms is wholly due to demand for decrease of surface in contact with a drying environment, or whether it is in part a mechanical response against destruction by being torn from their substrata by desert gales.

In general, the twenty-five lichens collected on the rocks of Tumamoc Hill are protected above by some sort of mechanical device, usually a definite pseudoparenchymatous cortex (and enclosed, dead algal cells), which protects the living algal cells and the fungal hyphae of the medullary layer against the drying effects of high winds and the direct rays of sunlight. Zukal has observed that the cortex is thicker in certain lichens growing in places where exposed more than usual to intense light and dry conditions than in the same species in less exposed positions.* One of the most helpful studies in connection with the present problem would be the comparison of some of the species with lichens of the same species from regions having average conditions of light, moisture, temperature, wind, etc., with respect to development of cortex. This, with a more exhaustive study of the functions of coloring matter in the cortex, would help to determine whether the development of cortex in lichens is, as Zukal thinks, mainly a light relation.†

* Zukal, H. l. c.

† Zukal, H. Op. c. 209. Mr 1896.

PROTECTIVE COLORATION

A remarkable thing about these rock-inhabiting lichens from Tumamoc Hill is the more or less evident development of black lines or spots on the upper surface of every species having a light-colored thallus. These lichens or spots are so numerous on older portions of some of the thalli as to darken, more or less, the otherwise light-colored surface. The lines are most conspicuously developed on some of the thalli of *Acarospora xanthophana* and *Parmelia conspersa,* and it was at first thought that they represented parasitic fungi, but sectioning showed that they do not. Zukal, in his excellent discussion of the protective significance of colors in lichens, speaks of such lines of black as occurring on younger or injured portions of thalli to protect the algal cells from the intense rays of sunlight in hot regions;* but the writer found the lines and spots better developed over older portions of thalli and noted that they were frequently developed in connection with cracks in the thalli; nor were the algal cells any more numerous, so far as could be determined, under these black areas than elsewhere in the same thalli. *Parmelia conspersa, Acarospora xanthophana* and *Lecanora muralis* all showed more or less of black margins, which doubtless protect the younger and more tender algal cells of these margins where the cortex is still thin. It was thought that in some of the areolate forms as *Buellia lepidastra* and *Acarospora xanthophana,* in which the thallus is compound, each areole really representing an independent development, the black lines might have been developed at first along the margins and become dorsal by subsequent growth of the areole; but, were this the case, the lines would be as numerous on younger as on older portions of thalli. Besides the species mentioned above, these lines and spots were readily noted in *Acarospora xanthophana dealbata, Acarospora cineracea, Lecanora cinerea* and *Lecanora calcarea contorta.* In section, under the microscope, the upper surface of older portions of some thalli showed the coloring matter often quite generally distributed; whereas under the hand lens it was only apparent where best developed as the black lines or spots, the protective coloration

* Zukal, H. Op. c. 218–221. Mr 1896.

apparently developing gradually from these centers with continued exposure and thus being more abundant in older portions of the thalli.

The isidioid branches were unusually well developed in *Parmelia conspersa* from the desert; and while these branches, of course younger than the horizontal thalli on which they developed, showed only slight and occasional development of the dark lines, they usually showed a brownish coloration at their exposed and tender, growing tips, after the manner of coloration of the tips of branches in many fruticose thalli, which is doubtless protective. *Placodium elegans* showed more or less of the development of darker areas in lighter thalli of the species; but it was not noted in any other thalli of general dark color, these thalli having sufficient coloration of the general surface for protection against intense rays of light in the desert. Nor was it noted that the thalli of any of the twenty-five species were otherwise more deeply colored than lichens of the same species from other regions, except through the development of the black areas and spots, which we must conclude are a protective device.

A very instructive study would be the observation of the relation of development of the black areas to the position of the particular plant on the rocks with reference to the sun's rays. Another problem of interest would be the study of the relation of development of coloration at the tips of the branchlets in *Parmelia conspersa* to the orientation of these branchlets with reference to the sun's rays.

SERIATIM CONSIDERATION OF STRUCTURE

We may now consider *seriatim* the structure of the thalli in the genera most frequently seen in the collections sent for study. *Endocarpiscum* is pseudoparenchymatous throughout, and the algal cells within are thus well protected against too intense light or too much transpiration of moisture, or both. *Acarospora* is also cellular throughout, so that the algal cells are unusually well protected for such small thalli. Like most other lichens whose thalli contain blue-green algal cells, *Endocarpiscum* seems to be confined to the most moist situations in the

area, in spite of its special protective devices. Species of *Acarospora,* on the other hand, form a large proportion of the list of twenty-five lichens of the rocks and are more often seen on rocks closely examined than those of any other genus. Perhaps *Acarospora xanthophana* is the most common lichen in the area studied, though the less conspicuously colored *Acarospora Carnegiei* may prove more common on close examination in the region. *Lecanora* has either an upper cellular cortex or a pseudocortex of entangled hyphae, and *Placodium* shows a similar structure. The one *Parmelia* is a very closely adnate species, which the writer has observed to possess a stronger cortex than the closely related *Parmelia caperata,* which usually grows in less xerophytic conditions. *Buellia* shows the special responses to need of protection in the well-developed exciples, hypothecia and paraphyses, which make its existence possible in the dry environment, while *Biatora,* closely related but less favored in these three respects, is entirely absent or so rare as to be entirely overlooked in collecting. *Buellia* has no cellular cortex above, and the algal cells and the surrounding fungal hyphae are protected above only by a thin pseudocortex of entangled hyphae. *Dermatocarpon* is well protected by strong cortices; and *Dermatocarpon miniatum,* the only species not closely adnate, is attached to the rocks by a very strong umbilicus, while the lower cortex is so strongly developed that no ordinary wind can tear the plants from the rocks. This plant is also able to maintain itself more effectively because tough and elastic like rubber when wet, so that, though pliable before the wind in this condition, it is scarcely more likely to be torn loose when wet than when dry. *Pyrenopsis, Endocarpon,* and the two species of *Verrucaria* were rarely seen in the collections and need not be considered important floral elements.

The Stations

The lichens sent for study were collected from seven stations. Station I is the bottom of the gulch a short distance west of the Desert Laboratory, altitude 762 m. The gulch runs northwest, and the lichens of the rocks were collected from rocks facing northward on the west side of the gulch. The lichens of

the rocks of the gulch are nearly all on the west side or near the bottom. This peculiar distribution is doubtless largely due to the fact that the rock faces of the east side of the gulch receive the direct rays of the afternoon sun. The lichens sent from the rocks of this station are numbers 8, 10, 12, 13, 15, 16, 17, 19, 20, 22, 23, 26, 27, 32 and 33 of the list of species given above. The lichens found on the soil of the bottom of the gulch are numbers 6, 7 and 31. The rocks forming the walls of the gulch are basaltic.

Station II is a mass of basaltic boulders, forming a cliff facing southward on the south side of Tumamoc Hill, altitude 792 m. The collection was made from all sides of the boulders; and Mr. Blumer reported the south faces of the boulders to be very poor in lichen species and individuals, while the lichen flora is best developed and most highly colored on the north faces of the boulders. The lichens determined from this station are numbers 1, 2, 8, 10, 11, 12, 13, 16, 17, 19, 20, 21, 23, 26, 27 and 32. The similarity between the lichen species of the basaltic rocks of the first two stations will be apparent enough upon noting the similarity in numbering, and especially when one takes into account the genera represented by these numbers as well as the species. Mr. Blumer's notes regarding station II state that a number of moisture-requiring seed-plants, such as *Celtis pallida*, *Abutilon incanum*, *Encelia farinosa* and a *Eupatorium* grow about the rocks; and doubtless there are moist places on the rocks where numbers 1 and 2 grow. At least, the writer has found members of the genus *Endocarpiscum* growing in moist places elsewhere. The structural responses of the other lichens found in the first two sections were sufficiently considered in the general and in the *seriatim* statements of adaptations and need not be repeated.

Station III is a very steep slope facing directly south on the south side of Tumamoc Hill, altitude 823 m. The lichen habitat consists of loose blocks of tuff and basalt, especially the former, which have worked down from a quarry above. The habitat is a very dry one, and nothing exists on the ash-dry soil except a few bushes of *Larrea tridentata*. The lichens determined from this station are numbers 8, 9, 10, 11, 12, 13 and 16. The meagerness of lichen species here is very apparent, but it is not certain

whether this meagerness is due to the presence of the tuff or to the southern exposure. Mr. Blumer stated in a letter that the lichens seem to grow better on the basalt, but only one of the stations reported is composed entirely of tuff, so the question of relative suitableness of the two kinds of rocks for lichen substrata cannot be certainly solved from data at hand. Mr. Spalding and Mr. Blumer both stated in letters that lichens are very scarce on southward-facing rocks, the latter gentleman writing: "Their place of best development is on the northerly faces of basaltic rocks, where they are often beautifully conspicuous. On sunny aspects of rock faces they must be looked for to be found." However, the most remarkable thing about the short list of seven lichens found in this station is that five of them belong to the genus *Acarospora,* and that every species and subspecies of the genus known to occur on Tumamoc Hill is found in this one station. The writer must again refer to his work in Minnesota,* where he has found the genus represented in every one of the six lichen formations of exposed horizontal rocks studied, whether on granite, quartzite or pipestone, and in all but one by the species *Acarospora xanthophana.* Also, he must recur to his statement, in the paper on "A Lichen Society of a Sandstone Riprap,"† regarding the frequent occurrence of *Acarospora* on the southward-facing riprap and its very rare occurrence on the northward-facing riprap a few feet away. These data, with those of station III, establish beyond doubt that *species of Acarospora, with their strong protective cortices and their cellular structure throughout are the most characteristic xerophytes of all our American lichens thus far studied from the ecologic point of view.* They occur in xerophytic associations as a small proportion of the plants of lichen formations in exposed environments in regions for the most part mesophytic, and are found at station III making a very large proportion of a lichen aggregation on the southward-facing, dry and often hot rocks of a desert region.

Station IV is in the same locality as station II, but differs in that it is an outcrop of tuff facing eastward at the bottom of the exposure. The plants determined from this station are numbers

* Fink, Bruce. Op. c. and other papers of the same series.

† Fink, Bruce. Op. c. 278.

1 and 2 of the list. The eastward-facing tuff at the bottom of the exposure is doubtless often moist, so that *Endocarpiscum* finds a favorable habitat. It is not a little remarkable that the tuff, even at the base of the exposure, gave only two lichens; and, while it can hardly be possible that the absence of other lichens from the formation is more than a singular accident in distribution, if indeed the collecting was in this instance carefully done, the data at hand tend strongly to prove that tuff is a very poor substratum for lichens.

Station V is a northward-facing basalt cliff on the north side of Tumamoc Hill, just west of its summit, altitude 914 m. Mr. Blumer thinks that this is perhaps as moist and cool a place as can be found about the Desert Laboratory, but he writes that even here lichens are absent from certain rock crevices and faces that are perennially dry, and are for the most part limited to such surfaces as are frequently wet or moist. The lichens found in this station are numbers 6, 7, 8, 10, 13, 15, 16, 19, 23, 26, 27, 30 and 33. The general similarity of this list of lichens and that of station I is apparent enough from the numbers, and it need only be stated that the gelatinous lichens which commonly grow in moist and shaded habitats are represented on the rocks here by numbers 6 and 7. This comparatively moist and cool station is the only one at which these species were found upon the rocks. The failure to get *Endocarpiscum* from this station is doubtless due to an oversight in the collecting.

Station VI is at the bottom of the gulch west of the Desert Laboratory, on the north slope, about an old tuff quarry, altitude 747 m. The rocks are tuff, with a few basaltic boulders, and the station is drier than station V. The lichens found in this station are numbers 3, 4, 8, 9, 10, 11, 13, 15, 16, 17, 18, 19, 23, 26 and 33. The general similarity of this lichen assemblage to that in station I is readily seen. The present station shows a larger number of species of *Acarospora* than did station I, and the individuals of this genus predominate more plainly in the present station, if one may judge by the material sent. The tuff is doubtless a drier rock than the basalt, not holding water so well, and it would seem that is supports a fairly well developed lichen flora on the northward-facing exposures, but not on the southward-facing. How-

ever, station VI contains basalt as well as tuff, and this conclusion can not be regarded as secure until several stations composed entirely of tuff are examined. The prevalence of tuff in the present station doubtless accounts for the drier conditions which have given species of *Acarospora* in greater numbers.

Station VII is the north face of a basalt block near the Desert Laboratory. The lichens determined from this station are very similar to those from stations I and VI, and a consideration of them would add nothing of value.

Lichens of Soil and Trees

At all of the stations an effort was made to find lichens on the soil. At stations II, III, IV, VI and VII nothing was found on the earth, while from stations I and V were found numbers 5, 6, 7, 28, 30 and 31. Mr. Blumer stated that the lichens collected at station V were found on wet soil, nothing appearing to the eye on dry soil. Inconspicuous lichens are much more easily visible when moist, and this fact may account for the difference in appearance, but Mr. B. E. Livingston has found that the soil becomes air-dry for a considerable depth during dry seasons,* and it is more probable that the lichens of the soil, whose short rhizoids penetrate but a small portion of the distance down to soil moisture in drier situations, are for the most part confined to shaded places where the moisture is retained longer and where it is doubtless drawn upward along the faces and crevices of the rocks extending into the soil, so that the lichens can get more moisture from below than they could get by evaporation through the air-dry layer of soil above the caliche in drier places. A thorough study of the earth-inhabiting lichens of the region should be made, however few may be the number of species found, for the sake of the light that would be thrown upon general ecologic problems.

The lichen flora of the woody plants of the area must be very limited, for repeated requests for such material brought nothing but a few sterile and poorly developed specimens of a *Physcia* and a *Placodium*. These were collected on *Parkinsonia microphylla*, very close to the ground, among rocks on a north slope.

* Livingston, B. E. The Relation of Desert Plants to Soil Moisture and to Evaporation. Pub. Carnegie Institution of Washington, 8. Au 1906.

RELATIONS TO MOISTURE AND AIR MOVEMENTS

It still remains to discuss several factors which influence lichen distribution in the area under consideration and at the same time to state several further problems that may well receive attention at some future time. Regarding the atmospheric conditions likely to influence lichen distribution, relative humidity and air movements are doubtless the most important factors. The relative humidity is known to be as low as eight per cent. of saturation about the Desert Laboratory, at times of special dryness in summer, and it varies from this to a high relative humidity during the rainy seasons. The ordinary winds blow from the east in the morning, later from the south, and by the middle of the afternoon from the west, while the gales may come from any direction. The drying winds from the east, south and west, day after day, doubtless interfere somewhat with the development of lichens on these three sides of outcrops of rocks, accentuating the effect of direct sunlight, thus leaving the northward-facing ledges by far the best habitats for lichens.

Mr. V. M. Spalding has shown certain desert seed-plants to absorb more or less water through their leaves and young shoots, some of them as much as nineteen per cent. of their weight,* and has also found that certain species of desert seed-plants absorb a very small amount of water vapor from a nearly saturated atmosphere, through their leaves and twigs.† He thinks that this absorption of water and water vapor through the leaves and twigs may be of some slight advantage.

H. Jumelle has experimented with lichens in somewhat similar fashion, in order to ascertain the amount of dryness of lichens in their habitats.‡ He collected several widely different species from trees and rocks, weighed them, placed them in a desiccator and weighed them again after drying. Jumelle's first experiments were performed upon lichens taken at a time when quite dry and supposed to be in a latent condition, and he found the

* Spalding, V. M. Biological Relations of Desert Shrubs.—II. Absorption of Water by Leaves. Bot. Gaz. **41**: 262–282. Ap 1906.

† Spalding, V. M. Absorption of Atmospheric Moisture by Desert Shrubs. Bull. Torr. Club **33**: 367–375. Jl 1906.

‡ Jumelle, H. Recherches Physiologiques sur les Lichens. Rev. Gen. Bot. **4**: 115. Mr 1892.

relation of fresh weight to dry weight to vary from 1.14 to 1 in *Parmelia acetabulum* to 1.21 to 1 in *Teloschistes parietinus.* He thinks that respiration and assimilation in lichens are reduced to almost *nil* in dry times. He found that *Cladonia rangiferina* and some other higher lichens can endure the dry condition for three months, and, upon the return of moist conditions, the life energies gradually return to their normal condition. Jumelle also experimented with lichens collected at times when they should be near their maximum regarding water content in their natural habitats, and got no very striking increase in the amount of water present in their thalli, the figures for *Parmelia acetabulum* at two different times being 2.07 to 1 and 1.38 to 1. He also dipped lichens into water several times, wiped them carefully and weighed them at once and also after drying. He found that the relation between the saturated weight and the dry weight is for *Parmelia acetabulum* 3.36 to 1, a proportion above the average for nineteen lichens experimented upon by him.

Jumelle has also experimented in similar fashion with seed-plants and has found that the proportion between fresh and dry weight varies from 10 to 1 up to 20 to 1. This shows that lichens, compared with seed-plants, contain very little water at any time, though the former are much more able to absorb water or water vapor in the proportions needed than are the latter, according to the experiments of Spalding. It must be further stated that Jumelle found a *Collema* dipped in water to show the surprising proportion of 35 to 1. He therefore concludes that the gelatinous lichens have a very high absorbing power. But these aside, lichens need very little water and are able to obtain all that is needed through the general surface, instead of through specialized organs as roots; the power of lichens to absorb water and water vapor through the general surface being high as compared with the results obtained by Spalding for the leaves and twigs of certain desert seed-plants. All considered, it may be assumed until otherwise proven, that lichens absorb at least a large proportion of the moisture needed, directly from water vapor of the atmosphere and from water falling upon them. However, so far as the writer can ascertain, the statements made by Jumelle do not rest upon experiments

made upon any desert lichens, and similar experiments with some of the lichens about the Desert Laboratory would certainly give some very instructive results.

Zukal, in summing up regarding the hygroscopicity of lichens, says: " Die Hygroskopicität ist für die Flechten eine höchst wichtige Eigenschaft, und nicht wenigen Arten ermöglicht sie geradezu die Existenz. Dies gilt besonders für die Bewohner jener Gegenden, wo es nur wenige Tage im Jahre regnet, wie dies z. B. in manschen Landschaften Chiles, Australiens und Nordafrikas der Fall ist."* It is doubtless true that hygroscopicity is of very considerable use to the crustose lichens of the deserts; though the most hygroscopic lichens are not the crustose ones, which seem to constitute almost the whole lichen flora of the desert area under consideration, nor yet the closely foliose ones that form a very small proportion of the lichen flora of Tumamoc Hill, but the loosely foliose and the fruticose species, especially those covered with hairs, cilia and free rhizoids. Experiments similar to those of Spalding and Jumelle, performed upon the crustose lichens of the desert in the driest condition in nature and giving the relation between fresh and dry weight, would give data regarding the amount of moisture retained in lichen thalli during the driest times in the desert. Accompanying this should go observations regarding the length of time that these lichens may be kept dry and then resume active respiration and assimilation on the return of favorable conditions.

Lichens can get water from the surface of the ground or rocks for a short time during and after each rain or wet season; but they have no special adaptation for storing water like cacti, nor have they organs extending any considerable distance into the soil or into rock crevices by which, like many seed-plants, they could extract soil moisture from any considerable depth. The retreat of the evaporating surface into the soil therefore leaves any lichens growing upon exposed soil entirely in an air-dry environment; consequently, the ability of these lichens, if lichens exist in such habitat, to absorb both water and water vapor from the atmosphere would be of special use to them in withstanding the effects of prolonged drought. This brings us to the ques-

* Zukal, H. Op. c. 1346. O 1895.

tion of how much moisture the lichens of the rocks in the desert may be able to obtain from upward passage through the rocks. It is well known that rocks are more or less porous and that the pores are larger toward the surface, porosity ranging from less than one per cent. to thirty per cent. or more. C. R. Van Hise states that water may rise 166 meters by capillarity, that, after it has ascended as high as it can by capillarity, it will still, through molecular attraction, creep along the walls of the pores " from areas of greater to areas of less humidity," and that there is no limit to such movement.*

No reliable data are at hand regarding the porosity of the tuffs and basalts of Tumamoc Hill and the amount of water that reaches the surface through them. The basalt is more dense and less porous than the tuff, and the latter may, like the soil, give off moisture so rapidly as to become too dry to support lichens very successfully through periods of prolonged drought. The less porous basalt doubtless gives off water vapor coming up from great depths very slowly, but perhaps in sufficient quantity to keep the lichens growing on these rocks alive in the driest times known in the desert; at least on surfaces often wet during the rainy season, and especially on northward-facing exposures where the effect of prolonged drought is felt least. Mr. Spalding stated, in answer to inquiry, that the lichens seem to be quite as numerous on large boulders as on the rock exposures *in situ*. The boulders do not extend to great depth; but if they extend below the lower limit of evaporating surface in the soil in driest times, the problem of distribution of lichens on them might not differ materially from that of their distribution on other rocks. This question of water supply for the lichens from the rocks below them is well worth investigation at the Desert Laboratory. It is certain that the supply obtained in this way is not alone sufficient to sustain lichens, for observation proves that these plants do not grow on desert rocks perennially dry. But the moisture thus obtained may be sufficient to keep the lichens alive during periods of extreme dryness, in situations where they may obtain moisture otherwise during rains and wet seasons.

* Van Hise, C. R. Treatise on Metamorphism. No. 753. Geol. Surv. Mon. **47**: 151. 1904. (House Documents, vol. 83.)

CONCLUSION

This brief study of the ecologic relations of some desert lichens should be of special interest, since it is the first one to appear. The workers in ecology have very largely confined their attention to seed-plants, but there is certainly a problem of great interest in the study of ecologic distribution of lichens in the desert as well as elsewhere. The writer has been at the disadvantage of not being able to see the field, and had it not been for the painstaking manner in which Mr. Spalding answered all inquiries and the careful collecting and note-taking of Mr. Blumer, the results herein presented would not have been possible. The writer realizes very fully that there are other problems concerning the distribution of lichens in the area herein considered, doubtless of as great importance as the ones discussed or suggested herein, that would present themselves during the progress of a study of the problem in the field.

While the writer was studying the ecologic problems, a number of the lichens collected were sent by him to Mr. Theodor Hedlund and to Mr. A. Zahlbruckner in Europe for aid in the taxonomic study. Thanks are due to both of these gentlemen for their aid in the work. Six new species and one new subspecies result from the work of Zahlbruckner (see Bull. Torr. Club **35**: 297–300. Je 1908).

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DISCOMYCETES OF NORTH DAKOTA

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The following is a list of the discomycetes (cup-fungi) collected and studied in North Dakota during the seasons of 1907–8. When not otherwise indicated the collections were made by the writer.

Hymenium exposed from the first, plants not usually cup-shaped, disc-shaped, boat-shaped or linear. — 1. HELVELLINEAE.
Hymenium at first closed, plants cup-shaped, disc-shaped, boat-shaped or linear, opening by a circular, star-like or slit-like aperture.
  Hymenium exposed at an early stage, plants cup-shaped or disc-shaped. — 2. PEZIZINEAE.
  Hymenium long, enclosed in a firm covering, opening with a star-like or slit-like aperture.
    Opening for the most part with a star-like aperture. — 3. PHACIDIINEAE.
    Opening with a slit-like aperture. Plants boat-shaped or linear. — 4. HYSTERIINEAE.

1. HELVELLINEAE

Plant large, consisting of a stem and globose pitted head. — 1. MORCHELLA.

2. PEZIZINEAE

Plants small, 1–2 mm. in diameter, forming orange or salmon-colored masses 1–3 cm. in diameter on burnt soil. — 2. PYRONEMA.
Plants not forming confluent masses and not usually occurring exclusively on burnt soil (except a few species not here recorded).
  Externally clothed with dark-colored bristly hairs. — 3. LACHNEA.
  Externally naked or hairs when present light-colored, usually white.
    Plants large, 1–8 cm. in diameter, cup-shaped, urn-shaped or saucer-shaped.
      Plants stipitate, often attached to sticks in woods.
        Within scarlet, without whitish, slightly hairy. — 4. SARCOSCYPHA.
        Within and without dark brownish-black. — 5. URNULA.*
      Plants sessile, on wood, soil, etc.

* Often included with the Phacidiineae.

Juice turning yellow when flesh is broken.	6. GALACTINIA.
Juice remaining colorless.	7. PEZIZA.
Plants medium or small, 1 cm. or less in diameter.	
Occurring on dung of animals (except one species which occurs on old paper, cloth, etc., and a few others not here recorded).	
Spores entirely colorless.	
Asci 8-spored, plants yellowish, cinereous or flesh-colored.	
Plants with conspicuous, colorless spines.	8. LASIOBOLUS.
Plants without spines.	9. ASCOPHANUS.
Asci 32-spored, plants white.	10. THECOTHEUS.
Spores colored, at first bright purple, later brown.	
Spores free in the ascus.	11. ASCOBOLUS.
Spores united in a ball in the ascus.	12. SACCOBOLUS.
Occurring on wood, herbaceous stems, living leaves, etc.	
Plants superficial on the substratum.	
Clothed with a dense covering of soft, light-colored hairs.	
Plants sessile.	13. TRICHOPEZIZA.
Plants stipitate, stem often slender.	14. DASYSCYPHA.
Not clothed with hairs.	
Plants stipitate, stem stout, or slender.	
Stem short, stout, plants occurring on wood.	
Hymenium bright yellow, disc nearly plane.	15. HELOTIUM.
Hymenium smoky-brown, beaker-shaped.	16. GEOPYXIS.
Stem comparatively long and slender, on herbaceous stems, etc.	
Plants small, 1 mm. or less in diameter.	17. PHIALEA.
Plants medium, 3–5 mm. in diameter.	18. CIBORIA.
Plants sessile.	
Substance soft and plants not black in color.	
Medium, 3–5 mm. in diameter.	
Dark purple, rubbery, spores colorless.	19. CORYNE.

Greenish, spores colored, greenish-brown. 20. PHAEOPEZIA.
Small, not exceeding 2 mm. in diameter.
Plants disc-like, on leaves, wood, etc. 21. MOLLISIA.
Plants forming spots on leaves, alfalfa, etc. 22. PSEUDOPEZIZA.
Substance hard, forming black discs on wood, etc.
Spores with transverse septa only.
Spores 1-septate, brownish. 23. KARSCHIA.
Spores more than 1-septate, colorless.
Spores filiform, breaking into joints. 24. BACTROSPORA.
Spores not filiform. 25. PATELLARIA.
Spores muriform. 26. BLITRYDIUM.
Plants formed below the epidermis and bursting through usually in clusters.
Plants medium, 3 or more mm., usually cup-shaped. 27. CENANGIUM.
Plants small, 1–2 mm. mostly disc-shaped. 28. DERMATEA.

3. PHACIDIINEAE

Plants forming light-colored linear patches on old wood, etc. 29. PROPOLIS.

4. HYSTERIINEAE

Plants almost entirely superficial.
Lips spreading so that the plants become subpatellate. 30. HYSTEROPATELLA.
Lips tightly closed or only slightly spreading.
Spores muriform, with transverse and longitudinal septa.
Spores colored brown. 31. HYSTEROGRAPHIUM.
Spores colorless. 32. GLONIOPSIS.
Spores 1-septate, colorless. 33. GLONIUM.
Plants submerged, surface even with surface of substratum. 34. HYPODERMA.

1. HELVELLINEAE

1. MORCHELLA

MORCHELLA ESCULENTA (L.) Pers. A species well known by its stipitate, subglobose, deeply-pitted head. Commonly classed with the mushrooms and much valued for its edible qualities.

Observed by the writer from material collected by one of the students of the Agricultural College.

2. PEZIZINEAE

2. PYRONEMA

PYRONEMA OMPHALODES (Bull.) Fuckel. Forming salmon-colored patches often several cm. in diameter on soil where wood or rubbish has been burned. While the individual plants are small they run together so closely that they present the appearance of one continuous mass which is surrounded by a spider-web-like halo of mycelium. The species was collected often in North Dakota about Sykeston on damp soil where there was no apparent trace of fire, but the places had doubtless been burned over, as the plants are usually restricted to burnt places. Also collected elsewhere on soil which had been sterilized by heating.

3. LACHNEA

LACHNEA SCUTELLATA (L.) Sacc. Saucer-shaped plants as large as 1 cm. in diameter with a bright red hymenium surrounded by a border of dark-colored hairs. On wood and the surrounding soil. Collected at Sykeston.

LACHNEA SETOSA (Nees) Sacc. Occurring often closely crowded on decaying mossy logs in woods. Similar to the preceding but plants one-third as large and hairs much longer. Collected on old box-elder logs in woods near Fargo.

LACHNEA HEMISPHERICA (Wigg.) Gill. Hemispherical plants about the size of a large acorn-cup, growing on moist soil in shaded places in woods. Inside of cup whitish or bluish-white, externally clothed with chestnut-brown, bristly hairs. Collected in woods near Fargo.

4. SARCOSCYPHA

SARCOSCYPHA COCCINEA (Jacq.) Cooke. Plants found in woods in spring attached to partially buried sticks. Inside of cups, which are often 3 cm. or more in diameter, brilliant scarlet, outside whitish and more or less downy with soft white hairs.

One of the most attractive of the discomycetes on account of its brilliant color. Observed from material collected by one of the students of the Agricultural College.

SARCOSCYPHA OCCIDENTALIS (Schw.) Cooke. Habitat similar to that of the preceding but plants occur all summer. Stem usually longer and more slender, cups smaller and shallow, saucer-shaped instead of deep funnel-shaped as in the preceding. Collected commonly in woods about Fargo.

5. URNULA

URNULA CRATERIUM (Schw.) Fries. Occurring in woods on buried sticks, a number of specimens often attached to a single stick. Plants at first club-shaped and entirely closed, finally opening with a star-like aperture and becoming urn-shaped but margin usually notched. Outside and inside dark brownish-black. The position of this species is uncertain but on account of the manner in which the cups open the genus is often included with the Phacidiineae.

6. GALACTINIA

GALACTINIA SUCCOSA (Berk.) Cooke. Plants cup-shaped, rather large, 2–3 cm. in diameter, inside brown, externally whitish. When the flesh is broken the exuding juice turns golden-yellow. Occurring on damp soil in shaded woods. Collected near Fargo.

7. PEZIZA

PEZIZA VESICULOSA Bull. Large cup-shaped plants often 6–8 cm. in diameter, yellowish inside, whitish externally, occurring usually in dense clusters on strawy manure piles and soil fertilized with such material. The cups are at first regular in form, becoming much contorted and twisted. A common species. Collected at Sykeston.

PEZIZA REPANDA Wallr. This species occurs on decaying logs in woods, and, while it resembles the preceding in color, it differs in form, the cups soon becoming repand, leaving the hymenium convex. This is a species concerning which there is much doubt. The specimen collected near Fargo by the writer conforms with

what is usually accepted as this species. The plant was about 6 cm. in diameter.

PEZIZA BADIA Pers. The brown cup-fungus common on moist soil in woods. The specimens collected in Fargo woods were small, about 2–3 cm. in diameter, but the plants of this species often attain a size of 8–10 cm.

8. LASIOBOLUS

LASIOBOLUS EQUINUS (Muell.) Karst. The plants of this species while minute, usually occur in dense masses on dung of various kinds, especially that of horses and cows. The color varies from yellowish to reddish but the plants are always characterized by the thick covering of colorless spines. Collected on dung of horses at Sykeston.

9. ASCOPHANUS

ASCOPHANUS CINEREUS (Crouan) Boud. Plants occurring gregarious or densely crowded on dung of horses, and characterized by the grayish or often nearly black color. Collected on horse dung in a swampy place in open woods near Fargo.

ASCOPHANUS TESTACEUS (Moug.) Phill. Plants flesh-red, usually gregarious or scattered on hemp cloth, building paper, rags, etc. Specimens collected near Fargo were found on building paper near the remains of an old house.

ASCOPHANUS CARNEUS (Pers.) Boud. Similar in color to the preceding but differing in its habitat as well as in morphological characters. Rather a common species on old cow dung. Collected commonly about Sykeston.

10. THECOTHEUS

THECOTHEUS PELLETIERI (Crouan) Boud. Plants white, at first conical, later cylindrical. Common on dung of various kinds and easily characterized by its 32-spored asci, as well as by its gross characters. Collected in woods near Fargo.

11. ASCOBOLUS

ASCOBOLUS IMMERSUS Pers. Plants small and not easily seen as they closely resemble in color the substratum on which they occur, but often occurring in abundance. Characterized by the asci filled with dark purple spores which project far above the surface of the hymenium. The spores in this species are unusually large. Collected near Sykeston.

12. SACCOBOLUS

SACCOBOLUS KERVERNI (Crouan) Boud. Plants small, golden-yellow, with the hymenium dotted with the ends of the asci containing dark purple spores. A common species on dung of cows. Specimens collected at Sykeston.

SACCOBOLUS VIOLASCENS Boud. Differs from the preceding in that the plants are violet instead of golden-yellow. The species also differs in microscopic characters. Specimens collected at Sykeston on horse dung.

13. TRICHOPEZIZA

TRICHOPEZIZA SULPHUREA (Pers.) Fuckel. Plants small, occurring on herbaceous stems and characterized by a dense covering of sulphur-yellow hairs. Collected at Fargo.

TRICHOPEZIZA TILIAE (Peck) Sacc. Plants small, white, and clothed externally with a dense covering of white hairs. Common and abundant on the bark of dead branches of basswood (*Tilia Americana*). Collected commonly about Fargo.

14. DASYSCYPHA

DASYSCYPHA NIVEA (Hedw.) Sacc. Plants stipitate and clothed with a dense covering of white hairs. Specimens collected on herbaceous stems at Hawk's Nest. The species is common on decaying wood, especially oak.

15. HELOTIUM

HELOTIUM CITRINUM (Hedw.) Fries. Plants very bright lemon-yellow, and usually occurring thickly gregarious on old

wood, and sometimes becoming slightly confluent. Collected in woods near Fargo.

16. GEOPYXIS

GEOPYXIS NEBULOSA (Cooke) Sacc. Plants medium in size, beaker-shaped, smoky-brown. Occurring on decaying logs in woods. The species is distinguished by its fusiform spores. Collected commonly about Fargo.

17. PHIALEA

PHIALEA URTICAE (Pers.) Sacc. Small, pale yellow plants with a slender stem. Collected commonly about Fargo on dead stems of nettle (*Urtica* sp.).

18. CIBORIA

CIBORIA SULPHURELLA (Ellis & Everh.) Rehm. Plants medium, stipitate, stem often very long or very short according to depth at which the substratum, petioles of ash leaves, is buried under leaves and soil. This species has been observed by the writer not only in North Dakota but commonly in Iowa and New York and apparently grows wherever the ash is found. The plants are very variable in color, ranging from sulphur-yellow or yellowish-green to reddish-brown. Collected at Hawk's Nest and Fargo.

19. CORYNE

CORYNE SARCOIDES (Jacq.) Tul. Often growing in clusters from crevices in decaying logs. Of a purple color and often very dark, with the substance inclined to be tough or rubbery. A common species. Collected near Fargo.

20. PHAEOPEZIA

PHAEOPEZIA FUSCOCARPA (Ellis & Holw.) Sacc. Plants saucer-shaped or disc-shaped, occurring on the under side or near the soil on rotting logs, dark colored with a shade of green, The spores of the species are also green, becoming brown. Collected in woods near Fargo.

21. MOLLISIA

MOLLISIA CINEREA (Batsch) Karst. Plants small or medium, saucer-shaped, with a light-colored border. Common on wood and decaying herbaceous stems. Collected commonly about Fargo. The specimens occurring on herbaceous stems may be distinct from those on wood but we can see no difference.

MOLLISIA DEHNII. Rabenh. On living leaves and stems of *Potentilla* sp. The plants, when they occur, almost entirely cover the leaves and stems of the host. They are small and disc-shaped and of a rather dark color. Collected at Fargo in the Agricultural College grounds.

22. PSEUDOPEZIZA

PSEUDOPEZIZA MEDICAGINIS (Lib.) Sacc. Forming minute brown leaf-spots on the living leaves of the host and causing much damage to the crop. Collected commonly at Fargo in the Agricultural College grounds, on leaves of alfalfa.

23. KARSCHIA

KARSCHIA TAVELIANA Rehm. Forming small black discs, often in considerable numbers, on partially decayed wood. Collected about Fargo on logs of decaying ash.

KARSCHIA LIGNYOTA (Fries) Sacc. Similar to the preceding but smaller and spores also different. Collected on old wood at Hawk's Nest.

24. BACTROSPORA

BACTROSPORA DRYINA (Ach.) Mass. The genus is represented by a single species, and no previous record of it has been seen from North America. Specimens collected on dead branches of *Symphoricarpus occidentalis,* by J. F. Brenckle, at Kulm, N. D.

25. PATELLARIA

PATELLARIA ATRATA (Hedw.) Fries. Plants similar in external appearance to those of the preceding genus but very different internally. Spores much larger, colorless and many-septate. Substance with transmitted light bluish. Hawk's Nest.

PATELLARIA CLAVISPORA (Peck.) Sacc. This species is very common on bark and wood of willow and cottonwood. The spores are very different in form and color from the preceding. Collected about Fargo.

26. BLITRYDIUM

BLITRYDIUM FENESTRATUM (Cooke & Peck) Sacc. Plants similar to those of the two preceding genera but spores much larger, broader, brown, and divided by both longitudinal and transverse septa, becoming muriform. Collected commonly on the bark of dead twigs of *Populus tremuloides*, in woods near Fargo.

27 CENANGIUM

CENANGIUM FURFURACEUM (Roth.) DeNot. Plants forming cespitose clusters bursting through the bark of the host. Collected commonly about Fargo on dead branches of *Corylus* sp. The cups remain for a long time closed, finally opening and becoming cup-shaped.

28. DERMATEA

DERMATEA sp. A species of this genus was collected in great abundance on dead branches of *Amelanchier* sp. in woods at Hawk's Nest. The species is still undetermined.

3. PHACIDIINEAE

29. PROPOLIS

PROPOLIS FAGINEA (Schrad.) Karst. Forming white lines often 1 mm. wide and several mm. long on old wood. The white surface constitutes the hymenium of the plant, which consists of asci, paraphyses and spores. Collected commonly in woods near Fargo.

4. HYSTERIINEAE

30. HYSTEROPATELLA

HYSTEROPATELLA PROSTII (Duby.) Rehm. Plants boat-shaped, and intermediate in form between *Patellaria* and *Hysterium*, the plants being at first hysteriform and later becoming subpatellate. Collected near Fargo.

31. HYSTEROGRAPHIUM

HYSTEROGRAPHIUM MORI (Schw.) Rehm. Plants linear, opening with a slit-like aperture, spores muriform, brown. Common on old wood of various kinds. Collected on old oak wood near Fargo.

HYSTEROGRAPHIUM FRAXINI (Pers.) DeNot. A very common and abundant species on bark and wood of ash. Dead branches still on the tree are often nearly covered with the small, boat-shaped plants. Very different from the preceding. The species has also been collected on *Xanthoxylum.*

32. GLONIOPSIS

GLONIOPSIS GERARDIANA Sacc. The species of this genus differ from those of the preceding in that the spores are colorless instead of brown. Collected on old oak wood, near Fargo.

33. GLONIUM

GLONIUM STELLATUM Mühl. Plants forming black stellate masses on old wood, the individual plants linear, opening with a cleft. The first appearance is a dense mass of black mycelium.

GLONIUM PARVULUM (Gerard) Sacc. Plants very small and parallel with each other, often occurring in great numbers and rather closely crowded. Collected on old stumps in woods near Fargo.

GLONIUM LINEARE (Fries) DeNot. Plants larger than the preceding and differing in spore characters. Collected on wood at Hawk's Nest.

34. HYPODERMA

HYPODERMA SCIRPINUM DC. Plants forming shining black lines on the stems of the host with a delicate slit extending lengthwise through the center. On stems of *Scirpus* sp. I am indebted to Dr. J. F. Brenckle for specimens of this species.

NEW YORK BOTANICAL GARDEN.

THE PERFECT STAGE OF THE COTTON ANTHRACNOSE

C. W. Edgerton

(With Plate 8, Containing Five Figures)

Perithecia of the genus *Glomerella,* the perfect stage of certain species of *Gloeosporium* and *Colletotrichum,* have been developed in most cases under artificial conditions, either in pure culture on artificial media or on old dead pieces of the host plant that have been kept in a moist condition. In only a few cases has the ascigeral stage been found developing naturally. The form from apple has been reported as occurring naturally, but even here the best development has been observed on artificial media or on diseased apples kept in a moist chamber.

While making a study of the cotton anthracnose, *Colletotrichum Gossypii,* in Louisiana during 1908, search was made at various times to discover whether the perithecial stage of this developed naturally on the cotton plant. Shear and Wood* have reported finding the perithecia in pure cultures, but their presence on the living cotton plant, or even on old dead parts of the plant, has never been reported. The anthracnose appears on all parts of the plant, cotyledons, leaves, stems and bolls, and search was made on all of these for the perfect stage. The conidial stage was especially abundant, and it is doubtful whether there was a single cotton plant in this section of the cotton belt that was not more or less affected with this stage, and, during the early part of the season, this stage alone was found.

However, on August 1, after a period of very warm and very wet weather, a single boll, picked while passing through a field at Baton Rouge, was examined in the laboratory and found to be covered with the perfect stage of the *Colletotrichum.* The boll was living, only about one half of it being covered with the

* Shear, C. L., and Wood, Anna K. Ascogenous Forms of *Gloeosporium* and *Colletotrichum.* Botanical Gazette **43**: 259–266. 1907.

anthracnose, while the other half was perfectly green and healthy. Two days later, six bolls picked at random in different parts of the same field were examined, and three of them were found to contain perithecia. In only one case did the anthracnose cover the whole boll. On August 8, after a few days of comparatively dry weather, over a hundred bolls were brought in from the same field, but only two of these contained perithecia and they were small withered bolls. Again, on August 25, after another wet spell, fifty bolls were brought in from the same field and the perfect stage was found on four of these. In another field about a mile distant from the first one, bolls were also examined but with less success. Forty bolls picked August 4 showed no perithecia. However, toward the latter part of August, several bolls out of a considerable number were found to contain the perfect stage. From the conditions of temperature and humidity at the time, it seems possible that moisture and heat may be important factors in perithecial development in this species.

The study of the perithecia showed several interesting things. The perithecia were, as a rule, entirely embedded in the host tissue and only the more or less well-developed beaks extended through the epidermis of the boll. In only one instance (*pl. 8, f. 2*) were the perithecia observed on the surface of the boll. They were not collected together surrounding a nodule of fungus tissue as is commonly the case in this genus, but were more or less distinct and separate. Often they were so numerous that they crowded one another, but only rarely did they seem to have any connection with a common fungus stroma; often, also, the perithecia were entirely separate, each one being entirely surrounded by host tissue (*pl. 8, f. 3*).

A second interesting feature was the shape of the ascospores. *Glomerella* spores are generally more or less curved and elongate, while these were rarely curved and more elliptical (fig. 1, *a, b*). I have had the opportunity of studying spores from a number of different host plants, but I have seen in no other form, the short, thick, elliptical spores like those which occurred on the cotton. I have shown as a comparison, in fig. 1, *c*, ascospores that developed on the fig, *Ficus carica*. The perfect stage of this form has not hitherto been reported, but it does

not seem in any way distinct from the one on apple, *Glomerella fructigena* (Clinton) Sacc. Whether the shape of the ascospores of the cotton anthracnose was due to environment is a question. There is often considerable variation in the size of the ascospores from the same host as developed on different substrata, the spores developing on the host plant being as a rule smaller than those developing on nutrient media, but I have not noticed a varia-

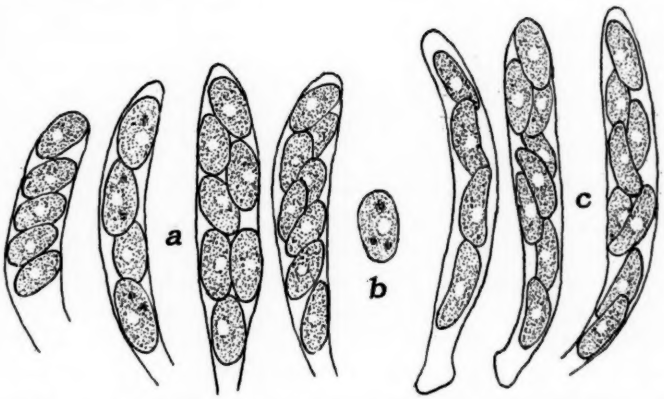


FIG. 1. Asci and ascospores of *Glomerella*. *a*, *Glomerella Gossypii*, asci and *ascospores*; *b*, same, typical ascospore; *c*, *Glomerella* from fruit of *Ficus carica*, showing asci and ascospores. All magnified 750 diameters.

tion in shape. As I have never seen ascospores of the cotton anthracnose that have developed on artificial media, I cannot compare them with those that developed naturally. But this difference in shape seems noteworthy and may represent a specific character.

A third feature, and the most interesting, developed from a study of the sterile threads which are now generally conceded to be present in all perithecia in this genus. The genus has been described at various times as (*a*) without paraphyses, (*b*) with paraphyses, and (*c*) with periphyses. These threads were so especially abundant in the perithecia from the cotton boll, that a good opportunity was offered for settling the point beyond a question. A large number of sections from 2 to 8 μ in thickness were made and studied. In many of the sections the sterile

threads were clearly seen, and their exact position in regard to the asci was shown. The presence of the threads between the asci was demonstrated with a certainty and can be clearly seen in the accompanying photomicrographs. While I have made scores of slides from other host plants, I was never before able to demonstrate their presence between the asci, and in a previous paper I expressed a doubt as to their occurrence in that position. The reason evidently lay in the better development of the threads in the perithecia from the cotton. These threads are much longer than the asci, extending to the ostiole of the perithecium, and entirely filling the cavity above the asci. If these sterile threads are to be called paraphyses, and there is little reason why they should not be called so, notwithstanding their length and irregularity, then the genus *Glomerella* must in the future be considered as paraphysate.

What effect this may have on retaining or discarding the generic name, *Glomerella,* cannot be told until some one has made a careful study of the various species of the genus *Physalospora.* Some of the perithecia of the cotton anthracnose fit perfectly the characters of the genus *Physalospora,* as shown in fig. 3, of the accompanying plate; however, others, as in fig. 2, do not. *Glomerella* perithecia, on artificial media or in a moist chamber, generally develop on the surface of the substratum and are not embedded in it, while *Physalospora* perithecia are not supposed to develop in this manner. But if it is found that members of this latter genus will develop on the surface of the substratum if the moisture conditions are suitable, then there are no generic characters separating the forms now resting in *Glomerella* and *Physalospora.* Several mycologists, such as Maublanc and Lasnier in France, and Sheldon in this country, are now calling the anthracnose forms *Physalospora;* but, until we know more of the development of these different forms, it seems best to keep them separate.

Although many of the anthracnoses found on different hosts are members of a single species, as has been shown by various investigators in the last few years, the evidence seems to show that some forms are distinct enough to represent different species. While morphologically the different forms are in many ways

similar, yet in some details there is considerable divergence in some of them. The form from cotton represents, perhaps, one of the most divergent types. I have studied this for some time and find no evidence for placing it in the same species with the organism causing the rot of various fruits. I have made many cultures at different times and from different places and find little variation in them. The characters which distinguish this from other forms may be briefly stated as follows: (1) A difference in color of the masses of spores, the cotton anthracnose spore-masses being more salmon than pink in color; (2) the abundance of setae; (3) the production of spores on the points of the setae; (4) the entirely distinct cultural characters; (5) the inability to inoculate satisfactorily other forms on cotton, or the cotton form on fruits, etc.; (6) the slight difference in the shape of the ascospores.

Consequently, believing that the evidence is sufficient to keep this form separate, I propose for it the following name and diagnosis:

Glomerella Gossypii sp. nov.

Perithecia distinct or crowded, very abundant, buried in the tissue of the host with only the beaks protruding, or rarely on the surface, dark brown to black, subglobose to pyriform, 80–120 × 100–160 μ, mostly about 115 × 140 μ. Beak of the perithecium sometimes 60 μ or more in length. Asci numerous, clavate, 55–70 × 10–14 μ, mostly 10–11 μ in thickness. Spores uniseriate or irregularly biseriate, nearly elliptical, or rarely slightly curved, granular, hyaline, showing a clear nucleus near the center, 12–20 × 5–8 μ, averaging 13–14 × 7 μ. Paraphyses long, slender, very abundant, filling the entire cavity of the perithecium above the asci.

Perfect stage of *Colletotrichum Gossypii* Southworth, which preceded and accompanied it. Bolls of *Gossypium herbaceum*, August, 1908, Baton Rouge, La. Type material, with prepared sections, deposited in the United States National Herbarium, Washington, D. C.

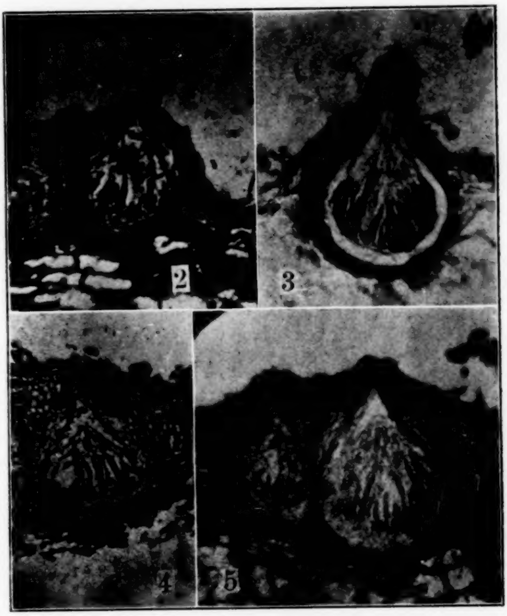
LOUISIANA AGRICULTURAL EXPERIMENT STATION.

EXPLANATION OF PLATE VIII

FIGS. 1–5. *Glomerella Gossypii* sp. nov.

1. Perithecium showing the paraphyses, × 320.
2. Perithecium on surface of cotton boll, × 200.
3. Perithecium showing the beak that is commonly present, × 200.
4. An entirely imbedded perithecium, section $2\,\mu$ thick, showing three asci and the paraphyses between them, × 200.
5. Perithecium showing asci, paraphyses, and short beak, × 200.

1



GLOMERELLA GOSSYPII EDGERTON

ASCOMYCETES AND LOWER FUNGI—FASCICLE II

Guy West Wilson and Fred Jay Seaver

26. Albugo bliti (Biv.) Kuntze, Rev. Gen. Pl. **2**: 658. 1891

Uredo bliti Biv. Stirp. Rar. Sicilia **3**: 11. 1815.

On *Amaranthus retroflexus* L. Lapel, Ind., August 22, 1907. G. W. W.

27. Albugo bliti (Biv.) Kuntze

On *Amaranthus spinosus* L. Carmel, Ind., August 29, 1907. G. W. W.

28. Albugo Portulacae (DC.) Kuntze, Rev. Gen. Pl. **2**: 658. 1891

Uredo Portulacae DC. Fl. France **5**: 88. 1815.

On *Portulaca oleracea* L. Lapel, Ind., August 22, 1907. G. W. W.

29. Basidiophora Kellermanii (Ellis & Halsted) G. W. Wilson, Bull. Torrey Club **34**: 349. 1907

Peronospora Kellermanii Ellis & Halsted, *pro tem.;* Ellis & Everh. N. Am. Fungi *2201*. 1889. (hyponym.)

Plasmopora Kellermanii Swingle; Sacc. Syll. Fung. **9**: 342. 1891.

On leaves of *Iva xanthiifolia* (Fres.) Nutt.; Sykeston, N. Dak., summer, 1907. F. J. S.

While of a rather restricted range this species appears to be abundant in the territory which it infests, and is probably coextensive in range with its host.

30. Blitrydium fenestratum (Cooke & Peck) Sacc. Syll. Fung. **8**: 805. 1899

Patellaria fenestrata Cooke & Peck; Peck, Ann. Rep. N. Y. State Mus. **28**: 68. 1876.

Fargo, N. Dak., August, 1907. F. J. S.

This species is rather common in the above locality on dead twigs of *Populus tremuloides* Michx.

31. FUSICOCCUM CASTANEUM (Sacc.) Sacc. Syll. Fung. **3**: 249. 1884

Cytispora Castanea Sacc. Michelia **1**: 519. 1879.

On dead branches of *Castanea dentata* (Marsh.) Borkh., New York City, March, 1907. G. W. W.

This fungus was nowhere observed except on the immature twigs of a large branch which had been broken from a chestnut tree during a storm of the preceding summer.

32. GIBBERELLA PULICARIS (Fries) Sacc. Michelia **1**: 43. 1876

Sphaeria pulicaris Fries, Syst. Myc. **2**: 417. 1823.

On old stalks of *Zea Mays* L., Mount Pleasant, Iowa, summer, 1907. F. J. S.

33. HYPODERMA AQUILINA (Fries) Rehm, Ber. Naturh. Ver. Augsburg **26**: 68. 1881

Sphaeria aquilina Fries, Syst. Myc. **2**: 522. 1823.

On old leaf-stems of *Onoclea sensibilis* L., New York City, spring, 1907. F. J. S.

34. *Hypomyces Lactifluorum* (Schw.) Tul. Sel. Fung. Carp. **2**: 63. 1865

Sphaeria Lactifluorum Schw. Schr. Nat. Ges. Leipzig **1**: (30). 1822.

On some species of *Lactaria,* Fargo, N. Dak., summer, 1907. F. J. S.

Numerous specimens of the host were collected in woods near Fargo all of which were entirely parasitized by the fungus so that the gills were entirely eliminated.

35. HYPOMYCES POLYPORINUS Peck, Ann. Rep. State Mus. **26**: 84. 1874

On *Coriolus versicolor* (L.) Quel. = *Polyporus versicolor* (L.) Fries, Fargo, N. Dak., summer, 1907. F. J. S.

The present species was found in considerable quantity during

the past season on old sporophores of the host. The specimens have been compared with authentic material received from Professor Peck and conform well.

36. HYSTEROGRAPHIUM FRAXINI (Pers.) de Not. Disp. Pirenom. Ister. 22. 1847

Hysterium Fraxini Pers. Syn. Meth. Fung. 100. 1801.

On dead twigs of *Fraxinus,* Sykeston, N. Dak., July, 1907. F. J. S.

This fungus is very abundant on dead twigs of ash wherever the later occurs in considerable numbers.

37. MASSARIA INQUINANS (Tode) Fries, Summa Veg. Scand. 396. 1849

Sphaeria inquinans Tode, Fungi Meckl. **2**: 17. *pl. 10, f. 85.* 1791.

On *Viburnum dentatum* L., The Bronx, New York City, spring, 1907. F. J. S.

The perithecia are very large and buried with the ostiola extending through the bark. The spores spread over the surface of the bark and are so large that with the hand lens they appear as coarse shining granules. The species is distinguished by the large size of its spores.

38. MITRULA PHALLOIDES (Bull.) Chev. Fl. Paris **1**: 114. 1826

Clavaria phalloides Bull. Herb. France. *pl. 463. f. 3.* 1791.

On decaying leaves submerged in water in a swamp, New York City, spring, 1907. F. J. S.

39. MOLLISIA CINEREA (Batsch) Karst. Myc. Fenn. **1**: 189. 1871

Peziza cinerea Batsch, Elench. Fung. Cont. **1**: 197. 1786.

On herbaceous stems in swampy place, New York City, spring, 1907. F. J. S.

40. PERONOSPORA EFFUSA Rabenh. Herb. Myc. ed. I. 1880

On *Chenopodium album* L., Greencastle, Ind., August 3, 1907. G. W. W.

The bright yellow epiphyllous discolorations of this fungus were very conspicuous during the late summer in all patches of the host, not only here but in other sections of the state.

41. PHYLITAENA ARCUATA Berk. Grevillea **2**: 100. 1874

On dead stems of *Ambrosia trifida* L., The Bronx, New York City, March, 1907. G. W. W.

This species is rather common in the vicinity of New York on herbaceous stems, but is easily overlooked on account of the inconspicuous habit and the peculiar hypha-like spores which are $25–30 \times 1–2\ \mu$.

42. PHYLLACHORA GRAMINIS (Pers.) Fuckel, Symb. Myc. 216. 1869

Sphaeria graminis Pers. Syn. Meth. Fung. 30. 1801.

On leaves of *Elymus canadensis* L., Fargo., N. Dak., autumn, 1907. F. J. S.

43. PHYLLOSTICTA SMILACIS Ellis and Everh. Bull. Torrey Club **27**: 572. 1900

On *Smilax rotundifolia* L., The Bronx, New York City, September, 1906. G. W. W.

The synonymy of this species is very much involved and the fungus apparently very poorly understood.

44. PROPOLIS FAGINEA (Schrad.) Karst, Myc. Fenn. **1**: 244. 1871

Hysterium fagineum Schrad. Jour. Bot. **2**: 68. 1799.

On decaying wood, Fargo, N. Dak., August, 1907. F. J. S.

45. RHYSOTHECA HALSTEDII (Farl.) G. W. Wilson, Torrey Club **34**: 403. 1907

Peronospora Halstedii Farl.; Ellis, N. Am. Fungi *209*. 1879 (hyponym). Proc. Am. Acad. **18**: 72. 1883.

On leaves of *Bidens frondosa* L., Noblesville, Ind., August 24, 1907. G. W. W.

During the latter part of the summer it was almost impossible to find a plant of this host which was unaffected with the fungus.

46. SAPROLEGNIA FERAX (Gruith.) Nees, Nova Acta Acad. Leop. **11**[2]: 513. 1823

Conferva ferax Gruith. Nova Acta Acad. Leop. 1821.

On dead fish, New York City, spring, 1907. G. W. W.

This species is reported as common in the vicinity of New York City on fish of various species.

47. SPHAEROPSIS LINDERAE Peck, Ann. Rep. N. Y. State Mus. **39**: 45. 1896

On dead branches of *Benzoin Benzoin* (L.) Coulter, Westchester Co., N. Y., March, 1907. G. W. W.

The fungus infests the younger branches, which appear to have been killed by the mycelium of the fungus, while the sporangia develop saprophytically.

48. SPHAEROPSIS MENISPERMI Peck, Ann. Rep. N. Y. State Mus. **24**: 86. 1886

On recently dead vines of *Menispermum canadensis* L., First Mt., Orange, N. J., September 26, 1906. G. W. W.

This species, which is similar in habit to the preceding, was frequently observed in the vicinity of New York City.

49. SPHAEROPSIS SMILACIS Ellis & Everh. Jour. Myc. **5**: 149. 1899

On dead stems of *Smilax rotundifolia* L., The Bronx, New York City, March 22, 1907. G. W. W.

Not common and usually associated with other imperfect fungi.

50. TRICHOPEZIZA TILIAE (Peck) Sacc. Syll. Fung. **8**: 428. 1889

Peziza Tiliae Peck, Ann. Rep. N. Y. State Mus. **24**: 96. 1886.

Abundant on dead branches of *Tilia americana* L., Fargo, N. Dak., summer, 1907. F. J. S.

NEWS AND NOTES

Hedwigia for February, 1909, contains a biographical sketch, by Lindau, with portrait, of Paul Hennings, late curator of fungi at the Berlin Botanic Garden. The substance of this sketch, with the exception of the biblography, was reproduced in the Botanical Gazette for March.

Professor Hennings was born in a village in Holstein in 1841, and, after a short term at school, became an assistant in the botanic garden at Kiel under Nolte. He afterwards matriculated at Kiel and spent a few months there in study, but was in the main self-taught. In 1874, he began work on the cryptogams at Kiel as assistant to Eichler, and was called by Eichler to Berlin for this work in 1880. After a few years at Berlin, he devoted himself entirely to building up and studying the mycological collections, and, in 1902, was appointed royal professor. His published papers are numerous, those on tropical fungi alone probably numbering over two hundred.

For a number of years, Professor Hennings' health has been failing, and his arduous duties have allowed him scarcely any time for rest or recreation. The recent death of his son was a sad blow to him. Being sensitive and reserved in disposition and poetic in temperament, he felt deeply and keenly. He was often misjudged because of his retiring nature, but was exceedingly friendly and helpful to those seeking assistance in mycological work.

The Florida Agricultural Experiment Station Bulletin, No. 94, contains a summary of the "Fungus Diseases of Scale Insects and Whitefly," by H. S. Fawcett. The climate of Florida is especially suited to the combating of scale insect diseases by the use of their natural enemies, the fungi, and nowhere else in the world have these agencies been employed for that purpose to such as extent as in that state. The fungi which naturally grow on scale insects cannot grow on plants, so that their introduction for combating the scale insect cannot result in injury to the crops themselves.

Some of the fungi which have been employed in this work are the red-headed fungus, *Sphaerostilbe coccophila* Tul., the white-headed fungus, *Ophionectria coccicola* Ellis and Everh., the black fungus, *Myriangium Duriaei* Mont., the yellow fungus of the whitefly, *Aschersonia flavo-citrina* P. Henn., the red fungus of the whitefly, *Aschersonia Aleyrodis* Webber, and the brown fungus of whitefly, which bears no scientific name. The fungi here named have been known for years and used successfully, but, to ensure success, observations and treatment must be conducted with care. The material for use in connection with this kind of work is supplied by private parties.

A later publication by the same author on the subject of "Fungi Parasitic upon *Aleyrodes citri*" has been prepared as a thesis at the State University of Florida. This account records two other species of fungi, *Verticillium heterocladum* Penz., and *Microcera* sp., which are parasitic on *Aleyrodes citri* R. & H. and on scale insects.

In an article by J. Lagarde on "*Conditions biologoques et répartition des champignons dans le massif de l'Aigoual*" (Bull. Soc. Myc. de Fr. **24**: 197–220. 1909), the author deals with the difficult and interesting question of the distribution of the higher fungi as determined by the character of different localities, which are grouped as follows: (1) Cultivated valleys, (2) chestnut and oak woods, covering the lower mountain slopes, (3) coniferous woods, especially those planted in pine, (4) beech woods, on the higher slopes, (5) wet ravines, (6) pastures and other exposed places not under cultivation.

A list of species is given for each of these groups, and the habitats of many of the species are discussed. In the cultivated valleys are found, *Agaricus campestris, Panaeolus papilionaceus,* several species of *Coprinus, Schizophyllum alneum, Coriolus versicolor,* etc. A much longer list is given for the chestnut and oak woods, species of *Amanita, Lactarius, Russula, Boletus* and *Tricholoma* being prominent. *Amanita caesarea* is cited as being adapted, like the chestnut, to sandy soil, or soil free from lime, and conditions of moderate temperature and humidity. Wood-destroying species are discussed briefly.

In the coniferous woods, which have succeeded beech woods, the boleti predominate, especially *Boletus flavus* and *Boletus luteus,* which require resinous substances in the soil, and *Lactarius deliciosus* is also common. The beech forests furnish a large number of fungi. Among the larger forms, species of *Amanita, Russula* and *Clavaria* are conspicuous. *Amanita muscaria, Boletus edulis, Cantharellus cibarius* and *Hydnum repandum* are common. In wet ravines, certain species of discomycetes are found; also *Boletus scaber* and a few other moisture-loving species. In pastures, *Lepiota procera, Agaricus campestris,* species of *Lycoperdon,* and *Marasmius oreades* are the most important.

This is a very inviting field for the student of plant relations and one of great importance in connection with the study of associated higher plants. It requires, however, special training in mycology.

Mr. A. O. Garrett, of Salt Lake, Utah, has for several years been collecting and distributing the parasitic fungi of Utah. The following notes on the methods he has found most satisfactory in collecting rusts will doubtless be of assistance to others:

"In collecting the rusts, manila envelopes in which pamphlets, etc., have been received, are found to be very serviceable. When collecting, the affected leaves are piled up between the thumb and forefinger of the left hand; and when the pile becomes sufficiently large, it is transferred to the manila envelope. This is repeated until a sufficient quantity is gathered. The envelope not only prevents the spores of one species from becoming mixed with those of some other, but the leaves are kept in better shape for transferring to the press later. Of course, the envelope will not be used a second time; nor, for that matter, will the paper in which the specimens have been pressed. In these days of such diverse ideas in botanical naming, it becomes imperative that portions of the host-plant should be collected with the fungus, so that its identity may be preserved throughout the series of revisions that take place.

"In preparing the fungi for distribution, 'home-made' enve-

lopes are not only superior in quality, but also cost about one fourth as much as those obtained from dealers in botanical supplies. These envelopes should be made from a good quality of bond paper. This paper comes in three sizes: 17×22, 17×28, and 19×24 inches. The 17×22 size cuts into nine pieces, each $5\frac{2}{3} \times 7\frac{1}{3}$. This can be folded into an envelope approximately $2\frac{1}{2} \times 6$; or, folding the other way, $3\frac{1}{4} \times 4\frac{1}{2}$. Larger envelopes are sometimes needed, and these can be cut from the 19×24 sheet. Cutting three times each way, the resulting piece is $6\frac{1}{3} \times 8$ inches. This folds into an envelope either $3 \times 6\frac{3}{4}$ or $3\frac{3}{4} \times 5$ inches.

"Labels can be printed most cheaply by having the work done at some printing shop that makes label-printing a specialty. Here they will be printed at approximately a third of the price charged by the local printer. The labels are fastened to the envelopes by white glue made about as thick as thin cream."

The thirty-first annual report of the North Carolina Agricultural Experiment Station contains a descriptive list of more than fifty of the common plant diseases of that state, by F. L. Stevens and J. G. Hall, illustrated by ten plates.

A discussion by Mr. Fred J. Seaver of "Color Variation in Some of the Fungi" (Bull. Torrey Club **35**: 307. 1908) calls attention to certain marked changes of color which occur in some species. The several illustrations, which are taken from the order Hypocreales, show the confusion resulting from the description of new species in this order, when based on color alone.

Under the title "Studies in North American Peronosporales—III" (Bull. Torrey Club **35**: 361. 1908), several new and noteworthy species are listed by Professor G. W. Wilson. No. IV of the same series of papers (Bull. Torrey Club **35**: 543. 1908) consists of a host index of the commonly recognized American species of the order.

The Tenth Report of the Michigan Academy of Science contains a paper by C. H. Kauffman (**10**: 63–84. 1908) on unreported Michigan fungi for 1907, with an outline of the gasteromycetes of the state. This outline of the puff-balls and their relatives should be exceedingly helpful to students of this group anywhere in the northern United States.

Mycorhiza-producing basidiomycetes are discussed in a short paper by L. H. Pennington in the Tenth Report of the Michigan Academy of Science (**10**: 47–49. 1908). After a brief review of the work of others, the author describes the observations which led him to add *Boletus speciosus, Russula emetica, Tricholoma transmutans,* and an additional species of *Cortinarius* to the list of higher fungi that may produce mycorhiza upon the roots of certain species of oak.

Bulletin 144 of the Bureau of Plant Industry of the U. S. Dept. of Agriculture contains an article by W. M. Scott and J. B. Rorer devoted to the cause and treatment of the Apple Blotch, a disease which is very destructive to apples and is widely distributed over the eastern part of the United States. The disease is caused by *Phyllosticta solitaria* Ellis & Everh., and attacks the leaves, branches and fruit, but is most conspicuous on the branches and fruit.

The first appearance of the disease on the fruit is a very small light brown blotch. The blotch spreads until it attains often a diameter of one half an inch. The fungus destroys only the outer layers of cells and the continued growth of the tissues beneath causes a cracking of the diseased areas, the cracks often being one half an inch long. The disease mars the appearance of the fruit and unfits it for the market.

The experiments of the authors of the article have shown that the disease may be controlled by spraying with Bordeaux mixture. Full details as to the application of the remedy are contained in the bulletin named above.